Advances in the Clinical Management and Treatment of Sports-Related Concussion:

The UPMC Sports Medicine Concussion program

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UPMC Sports Medicine
Agenda

- Overview of UPMC Sports Concussion Program
- Pathophysiology of Concussion
- In-Office Assessment
- Case Presentation
- Summary

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ReThinkConcussions.com
UPMC Sports Medicine Concussion Program

Established in 2000 as part of the Department of Orthopaedic Surgery
Treated patients from 25 colleges/universities
More than 17,000 patient visits
Patients traveled from 36 states as well as Washington, D.C. and multiple countries

3,439 Miles
Farthest distance traveled by a patient

Female Patients 54%
Male Patients 46%

BY THE NUMBERS

Treated patients involved in 17 different sports

7 - Age of the two youngest patients
74 - Age of the oldest patient

Treated patients from 15 professional sports teams

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Data is for Fiscal Year 2014

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Primary Care Practices

Athletic Trainers

Emergency Departments

Complicated-Out of Region Referrals

• Over 17,000 patient visits per year
• 6 clinics throughout Pittsburgh
• 20% of referrals out of region

UPMC Concussion Program (Neuropsych)

Primary Care Sports Med
PM & R
Vestibular/Exertion Physical Therapy
Neuro Radiology
Orthopaedic/Neurosurgery
Behavioral Neuro-Optometry

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Normal Neuron Function

- Dendrites
- Axon
- Nerve cell body
- Synapse
Normal Neuron Function

Signal travels down axon to another cell
Normal Neuron Function

Neurotransmitters are released in an organized manner, triggering the next cell with a specific coded message.
During injury, potassium ions (K⁺) rush out of the cell...
Neuron During Injury

...and toxic calcium ions ($\text{Ca}^{2+}$) rush into the cell, leading to metabolic dysfunction.

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Neuron Following Concussion

Metabolic dysfunction results in **ENERGY CRISIS**

Massive release of neurotransmitters interferes with cell communications

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Nerve cell is extremely vulnerable in this condition, and further injury or stress may cause **cell death or serious cell damage**.
Most Commonly Reported Symptoms
Athletes with Concussion — 1-7 days following concussion

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td># 1 Headache</td>
<td>75%</td>
</tr>
<tr>
<td># 2 Difficulty Concentrating</td>
<td>57%</td>
</tr>
<tr>
<td># 3 Fatigue</td>
<td>52%</td>
</tr>
<tr>
<td># 4 Drowsiness</td>
<td>51%</td>
</tr>
<tr>
<td># 5 Dizziness</td>
<td>49%</td>
</tr>
<tr>
<td># 6 Foggy</td>
<td>47%</td>
</tr>
<tr>
<td># 7 Feeling Slowed Down</td>
<td>46%</td>
</tr>
<tr>
<td># 8 Light Sensitivity</td>
<td>45%</td>
</tr>
<tr>
<td># 9 Balance Problems</td>
<td>39%</td>
</tr>
<tr>
<td># 10 Difficulty with Memory</td>
<td>38%</td>
</tr>
</tbody>
</table>

Kontos, et al., AJSM 2012; N = 1,438

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Factor Analysis, Post-Concussion Symptom Scale

N=1,438
High School & University Athletes at 1-7 Days Post-Concussion

Kontos, Elbin, Schatz, Covassini, Henry, Pardini, Collins; AJSM, 2012
Established Constitutional Risk Factors
For More Complicated Recovery Following Concussion

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Pellman, Lovell et al. <em>Neurosurgery</em>, 2006</td>
</tr>
<tr>
<td></td>
<td>- Kontos, Elbin, Collins, <em>Brain</em>, 2013</td>
</tr>
<tr>
<td>Female Gender</td>
<td>Colvin, Lovell, Pardini, Mullin, Collins, <em>AJSM</em>, 2009</td>
</tr>
<tr>
<td></td>
<td>- Covassinn et al, <em>CJSM</em>, 2009</td>
</tr>
<tr>
<td></td>
<td>- Mucha, Collins et al, <em>AJSM</em> 2014</td>
</tr>
<tr>
<td>Motion Sickness, Ocular Dysfunction</td>
<td>Kontos, Mucha, Collins, Data Under Review</td>
</tr>
</tbody>
</table>
UPMC Comprehensive Assessment Approach

- Neuro-cognitive
- Physical Exertion
- Vestibular
- Ocular-Motor
- Symptoms

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Concussion Clinical Trajectories: A Model for Understanding Assessment, Treatment, and Rehabilitation

Clinical Trajectories Determined by:
- Clinical Interview
- Vestibular-Ocular Screening
- Computerized Neurocognitive Testing

Findings lead to an individually determined treatment and rehabilitation plan

Using Concussion Clinical Trajectories to Inform Targeted Treatment Pathways

- Pre-Existing Risk Factors:
  - Previous Concussions
  - Migraine
  - LD/ADHD
  - Female Gender
  - Age
  - Motion sensitivity, Ocular Dysfunction

- Concussion

- Treatment and Rehab Pathways:
  - Vestibular
  - Ocular
  - Cognitive
  - Migraine
  - Anxiety/Mood
  - Cervical

Extensive Data Published on Risk Factors

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### UPMC Typical Evaluation

- **Clinical Interview**
- **Vestibular-Ocular Motor Screening**
- **Computerized Neurocognitive Testing**

#### Same day patient feedback

- Severity of Injury?
- Prognosis for Recovery?
- Neuroimaging indicated?
- PMR/Vestibular/Optometry referral?
- Level/type of Physical Exertion Allowed?
- Level of Cognitive Exertion Allowed?
- Academic Accommodations?
- Return to Play?

#### Communication to ATC, Team Physician, Referring Physician, etc.
Effective Treatment Planning: Behavioral Regulation

- Cognitive and physical rest must be conceptualized within a strict behavioral regulation plan:

  - **SLEEP**- Regulated sleep schedule, with similar bed time and wake time each day, including weekends. Dysregulated sleep can lead to fatigue, headache/migraine, and emotional distress. Avoid naps, unless napping was a part of your typical schedule prior to injury.

  - **DIET**- Follow a routine eating schedule, eating at the same time each day. Do not skip meals, especially breakfast, and aim at consuming a well-balanced diet.

  - **HYDRATION**- Dehydration can lead to fatigue, headaches, dizziness, and weakness. Recommend half body weight in ounces.

  - **PHYSICAL ACTIVITY**- Get some type of physical activity every day, even if it is just a light walk. Take a break if any symptoms reach a 3/10 severity. It’s important to remain involved in social, non-risk activities during recovery from concussion, utilizing as needed breaks for symptom management.

  - **STRESS MANAGEMENT**- Both physical and emotional stress can cause and/or worsen symptoms. Utilize academic or work accommodations to minimize stress. It is important to be mindful of situational and environmental stressors. Patients may benefit from psychotherapy with significant stress.
Case Study
College Hockey Player

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Concussion Clinical Trajectories

Clinical Trajectories Determined by:
Clinical Interview
Vestibular-Ocular Screening
Computerized Neurocognitive Testing

Concussion
Vestibular
Ocular
Cervical
Anxiety/Mood
Cognitive/Fatigue
Post-Traumatic Migraine

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Case Example: Collegiate Hockey Player
Case Example: Collegiate Hockey Player

- September 25, 2012
  - Brief loss of consciousness, 2 hour PTA, 45 second retrograde amnesia
  - Spine-boarded and transported to hospital-CT unremarkable
  - Attempted return to school 1 week later
    - Significant symptoms of frontal headache, fatigue, academic difficulties, mood changes
    - Removed from school for remainder of academic year
    - Told to “rest” with no physical activity
    - Referred to UPMC Concussion Program (Nov 5th)
  - Hx of two prior concussions (2006, 2008)
    - Both resolved within 7-10 day
  - No Other medical history
  - Family medical history of lazy eye
Case Example: Collegiate Hockey Player

- **UPMC Evaluation November 5, 2012** (6 weeks post injury)
  - Convalescing at home-No exertion allowed
  - Previously underwent full vestibular evaluation and determined vestibular therapy “not warranted”
  - Significant symptoms of fatigue (8/10 daily), frontal headache (7/10 daily), difficulties with “focus”, mood concerns (irritability, concern, dysphoria).
    - No dizziness, fogginess, phonophobia, sleep deficits
  - Headache/fatigue increased with reading and computer work

- UPMC Assessment and Evaluation
Case Example: Collegiate Hockey Player

- Testing November 5, 2012
  - Smooth pursuits, saccades, VOR, VMS, balance entirely WNL
  - Near point of convergence = 22cm
    - Convergence insufficiency
    - Marked right side exophoria
  - Exertional testing WNL
    - “Ecstatic” with working out-Mood improved immediately
  - Impaired computerized neurocognitive data
## Case Example: Air Force Hockey Player

<table>
<thead>
<tr>
<th>Composite Scores</th>
<th>Baseline</th>
<th>Post-Injury 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory composite (verbal)</td>
<td>91 73%</td>
<td>88 63%</td>
</tr>
<tr>
<td>Memory composite (visual)</td>
<td>93 96%</td>
<td>70 33%</td>
</tr>
<tr>
<td>Visual motor speed composite</td>
<td>43.22 68%</td>
<td>31.48 7%</td>
</tr>
<tr>
<td>Reaction time composite</td>
<td>0.5 87%</td>
<td>0.6 29%</td>
</tr>
<tr>
<td>Impulse control composite</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Total Symptom Score</td>
<td>0</td>
<td>23</td>
</tr>
</tbody>
</table>

**Cognitive Efficiency Index:** 0.43 0.34
Case Example:
Collegiate Hockey Player

- Recommendations for November 5, 2012 evaluation
  - Vision therapy through Behavioral Optometry
    - HTS program
  - No restrictions on exertion-full conditioning
  - Become socially active
  - Limited reading, computer work during initial stages of vision therapy
  - Prognosis excellent for resolution of symptoms/deficits/return to play with therapy (10 weeks)
Case Example: Collegiate Hockey Player

- Follow-up evaluation December 28, 2012
  - (4 months post injury-7 weeks after first eval)
    - Patient improving significantly
    - One headache per week (2/10-30 minutes in duration); fatigue/mood issues resolved
      - No other symptoms endorsed
    - Patient involved in full aerobic activity, lifting, skating-
      - Stage 5 hockey-specific activity with no contact
Case Example: Air Force Hockey Player

- Testing December 28, 2012
  - Computerized neurocognitive testing shows impaired reaction time
  - Near point convergence improved from 22 cm to approximately 9 cm
    - Right side exophoria still noticeable
## Case Example: Air Force Hockey Player

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<th>Baseline</th>
<th>Post-Injury 1</th>
<th>Post-Injury 2</th>
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<tr>
<td>Memory composite (verbal)</td>
<td>91  73%</td>
<td>88  63%</td>
<td>100  99%</td>
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<tr>
<td>Memory composite (visual)</td>
<td>93  96%</td>
<td>70  33%</td>
<td>88  86%</td>
</tr>
<tr>
<td>Visual motor speed composite</td>
<td>43.22  68%</td>
<td>31.48  7%</td>
<td>45.4  72%</td>
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<td>7</td>
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<tr>
<td>Cognitive Efficiency Index</td>
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<td>0.34</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Percentile scores if available are listed in small type.
Convergence Insufficiency
Case Example: Air Force Hockey Player

- Recommendations for December 28, 2012
  - Finish vision therapy
  - Return after vision therapy and prior to school year for clearance
  - Continue exertional activity with no restriction
Case Example: Air Force Hockey Player

- Final evaluation June 20, 2013 (9 months post injury)
  - Patient felt 100% recovered
  - Passed EXIT-Exertional testing
  - Finished vision therapy-NPC = 4 cm

- Computerized Neurocognitive Testing
# Case Example: Air Force Hockey Player

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<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Total Symptom Score</td>
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<td>7</td>
<td>4</td>
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<tr>
<td>Cognitive Efficiency Index:</td>
<td>0.43</td>
<td>0.34</td>
<td>0.26</td>
<td>0.57</td>
</tr>
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Sports Concussion Treatment: What Are We Learning?

- Concussion is a heterogeneous injury. Outcomes are highly variable and individualized.
- “Cookbook” approach to concussion management will never work.
- Active approaches to treatment are critical.
- Comprehensive and multidisciplinary centralized evaluation approach is necessary.
- Media hysteria driving public perception of injury.
- Concussion awareness with no treatment solution fosters helplessness with injury.